Claims

[c1] 1.A fused quartz article, said fused quartz article comprising:

a)a body, said body comprising fused quartz; and

b)a coating disposed on an exposed surface of said body, said coating comprising a plurality of metal cations, each having a valence of less than 4, wherein said plurality of metal cations comprises cations of at least one of an alkali metal, an alkaline earth metal, a rare earth metal, and combinations thereof, wherein said plurality of metal cations is present within said coating in a concentration of at least about 0.1 atomic percent, and wherein fused quartz within said body undergoes a transition to a cristobalite crystal structure at a temperature in a range from about 1000 ° C to about 1600 ° C.

[c2] 2.The fused quartz article according to Claim 1, wherein said fused quartz article is transparent to visible light.

[c3] 3.The fused quartz article according to Claim 1, wherein said fused quartz article is one of a furnace tube and a crucible.

[c4] 4.The fused quartz article according to Claim 1, wherein said fused quartz article is substantially chemically inert with respect to halide gases and acids.

[c5] 5.The fused quartz article according to Claim 1, wherein said fused quartz article has a melting temperature of at least that of cristobalite.

[c6] 6.The fused quartz article according to Claim 1, wherein said coating has a thickness from about 50 nm to about 5 microns.

[c7] 7.The fused quartz article according to Claim 6, wherein said coating has a thickness from about 500 nm to about 5 microns.

[c8] 8.The fused quartz article according to Claim 7, wherein said coating has a thickness from about 2 microns to about 5 microns.

[c9] 9.The fused quartz article according to Claim 1, wherein said plurality of cations comprises cations of at least one of barium, calcium, strontium, and combinations thereof.

[c10] 10.The fused quartz article according to Claim 1, wherein said at least one metal cation is present within said coating in a concentration of at least about 0.5 atomic percent.

[c11] 11.The fused quartz article according to Claim 10, wherein said at least one metal cation is present within said coating in a concentration from about 4 atomic percent to about 10 atomic percent.

[c12] 12.An outer coating for a fused quartz article, said outer coating comprising a plurality of metal cations, wherein said plurality of metal cations comprises cations of at least one of barium, calcium, strontium, and combinations thereof, and wherein said plurality of metal cations is present within said coating in a concentration of at least about 0.1 atomic percent, and wherein said plurality of cations catalyzes a transition of fused quartz within said fused quartz article to a cristobalite crystal structure at a temperature in a range from about 1000 ° C to about 1600 ° C.

[c13] 13.The outer coating according to Claim 12, wherein said outer coating is transparent to visible light.

[c14] 14.The outer coating according to Claim 12, wherein said outer coating has a thickness from 50 nm to about 5 microns.

[c15] 15.The outer coating according to Claim 14, wherein said outer coating has a thickness from 500 nm to about 5 microns.

[c16] 16.The outer coating according to Claim 15, wherein said outer coating has a thickness from about 2 microns to about 5 microns.

[c17] 17.The outer coating according to Claim 12, wherein said at least one metal cation is present within said coating in a concentration of at least about 0.5 atomic percent.

[c18] 18.The outer coating according to Claim 17, wherein said least plurality of metal cations is present within said outer coating in a concentration of from about 4 atomic percent to about 10 atomic percent.

[c19] 19.A fused quartz article, said fused quartz article comprising:

a)a body, said body comprising fused quartz; and

b)an outer coating disposed on an exposed surface of said body, said outer coating comprising a plurality of metal cations, wherein said plurality of metal cations comprises cations of at least one of barium, calcium, strontium, and combinations thereof, wherein said plurality of metal cations is present within said coating in a concentration of at least about 0.1 atomic percent, wherein said plurality of cations catalyzes a transition of fused quartz within said body to a cristobalite crystal structure at a temperature a temperature in a range from about 1000 ° C to about 1600 ° C, and wherein said fused quartz article is transparent to visible light.

[c20] 20.The fused quartz article according to Claim 19, wherein said fused quartz article is one of a furnace tube and a crucible.

[c21] 21.The fused quartz article according to Claim 19, wherein said fused quartz article is substantially chemically inert with respect to halide gases and acids.

[c22] 22.The fused quartz article according to Claim 19, wherein said fused quartz article has a melting temperature of at least that of cristobalite.

[c23] 23.The fused quartz article according to Claim 19, wherein said outer coating has a thickness from about 50 nm to about 5 microns.

[c24] 24.The fused quartz article according to Claim 23, wherein said outer coating has a thickness from about 500 nm to about 5 microns.

[c25] 25.The fused quartz article according to Claim 24, wherein said outer coating has a thickness from about 2 microns to about 5 microns.

[c26] 26.The fused quartz article according to Claim 19, wherein said at least one metal cation is present within said coating in a concentration of at least about 0.5 atomic percent.

[c27] 27.The fused quartz article according to Claim 26, wherein said wherein said plurality of metal cations is present within said outer coating in a concentration from about 4 atomic percent to about 10 atomic percent.

[c28] 28.A method of forming a doped coating on an exposed surface of a fused quartz article, the fused quartz article comprising a body comprising fused quartz and a coating disposed on an exposed surface of the body, the doped coating comprising a plurality of metal cations, each having a valence of less than 4, wherein the plurality of metal cations comprises cations of at least one of an alkali metal, an alkaline earth metal, a rare earth metal, and combinations thereof, wherein the plurality of metal cations is present within the doped coating in a concentration of at least about 0.1 atomic percent, the method comprising the steps of:

a)providing a silica slurry, the silica slurry being doped with a plurality of metal cations comprising cations of at least one of an alkali metal, an alkaline earth metal, a rare earth metal, and combinations thereof;

b)providing a fused quartz article;

c)applying the silica slurry to an exposed surface of the fused quartz article;

d)drying the silica slurry on the exposed surface; and

e)fire polishing the exposed surface to form the doped coating on the exposed surface.

[c29] 29.The method according to Claim 28, wherein the step of providing a silica slurry comprises providing a silica slurry doped with a plurality of metal cations, wherein the metal cations are selected from the group consisting of barium ions, calcium ions, and strontium ions.

[c30] 30.The method according to Claim 29, wherein the step of providing a silica slurry doped with a plurality of metal cations comprises providing a silica slurry doped with a plurality of barium ions.

[c31] 31.The method according to Claim 29, wherein the plurality of metal cations ions is present in the silica slurry in a concentration range from about 13 ppm to about 2000 ppm.

[c32] 32.The method according to Claim 31, wherein the plurality of metal cations ions is present in the silica slurry in a concentration range from about 800 ppm to about 2000 ppm.

[c33] 33.The method according to Claim 28, wherein the step of applying the silica slurry to an exposed surface of the fused quartz article comprises spraying the silica slurry onto an exposed surface of the fused quartz article.

[c34] 34.The method according to Claim 28, wherein the step of applying the silica slurry to an exposed surface of the fused quartz article comprises painting the silica slurry onto the exposed surface of the fused quartz article.

[c35] 35.The method according to Claim 28, wherein the step of applying the silica slurry to an exposed surface of the fused quartz article comprises dipping the fused silica article into a bath containing the silica slurry.

[c36] 36.The method according to Claim 28, further including the step of preheating the fused quartz article to a temperature in the range from about 50 ° C to about 70 ° C prior to applying the silica slurry to the exposed surface of the fused quartz article.

[c37] 37.The method according to Claim 28, wherein the doped coating has a thickness from about 50 nm to about 5 microns.

[c38] 38.The method according to Claim 37, wherein the doped coating has a thickness from about 500 nm to about 5 microns.

[c39] 39.The method according to according to Claim 38, wherein the doped coating has a thickness from about 2 microns to about 5 microns.

[c40] 40.The method according to Claim 28, wherein the plurality of metal cations is present within the doped coating in a concentration of at least about 0.5 atomic percent.

[c41] 41.The method according to Claim 40, wherein the plurality of metal cations is present within the doped coating in a concentration from about 4 atomic percent to about 10 atomic percent.

[c42] 42.A method of improving the creep-resistance of a fused quartz article, the fused quartz article comprising a body comprising fused quartz and a coating disposed on an exposed surface of the body, the coating comprising a plurality

of metal cations, each having a valence of less than 4, wherein the plurality of metal cations comprises cations of at least one of an alkali metal, an alkaline earth metal, a rare earth metal, and combinations thereof, wherein the plurality of at least one metal cation is present within the coating in a concentration of at least about 0.1 atomic percent, and wherein the body undergoes a transition to a cristobalite crystal structure at a temperature in a range from about 1000 ° C to about 1600 ° C, the method comprising the steps of:

a)providing a silica slurry, the silica slurry being doped with a plurality of metal cations comprising cations of at least one of an alkali metal, an alkaline earth metal, a rare earth metal, and combinations thereof;

b)providing a fused quartz article;

c)applying the silica slurry to an exposed surface of the fused quartz article;

d)drying the silica slurry on the exposed surface;

e)fire polishing the exposed surface, wherein the silica slurry, after drying forms a doped coating on the exposed surface; and

f)heating the fused quartz article and the doped coating to a temperature in a range from about 1000 ° C to about 1600 ° C, thereby nucleating cristobalite crystals on the exposed surface, wherein the cristobalite crystals enhance the creep resistance of the fused quartz article.

[c43] 43.The method according to Claim 42, wherein the step of providing a silica slurry comprises providing a silica slurry doped with a plurality of metal cations, wherein the metal cations are selected from the group consisting of barium ions, calcium ions, and strontium ions.

[c44] 44.The method according to Claim 43, wherein the step of providing a silica slurry doped with a plurality of metal cations comprises providing a silica slurry doped with a plurality of barium ions.

[c45] 45.The method according to Claim 42, wherein the plurality of metal cations is present in the silica slurry in a concentration range from about 13 ppm to about 2000 ppm.

[c46] 46.The method according to Claim 45, wherein the plurality of metal cations is present in the silica slurry in a concentration range from about 800 ppm to

about 2000 ppm.

[c47] 47.The method according to Claim 42, wherein the step of applying the silica slurry to an exposed surface of the fused quartz article comprises spraying the silica slurry onto an exposed surface of the fused quartz article.

[c48] 48.The method according to Claim 42, wherein the step of applying the silica slurry to an exposed surface of the fused quartz article comprises painting the silica slurry onto the exposed surface of the fused quartz article.

[c49] 49.The method according to Claim 42, wherein the step of applying the silica slurry to an exposed surface of the fused quartz article comprises dipping the fused silica article into a bath containing the silica slurry.

[c50] 50.The method according to Claim 42, further including the step of preheating the fused quartz article to a temperature in the range from about 50 ° C to about 70 ° C prior to applying the silica slurry to the exposed surface of the fused quartz article.

[c51] 51.The method according to Claim 42, wherein the step of heating the fused quartz article and the doped coating to a temperature in a range from about 1000 ° C to about 1600 ° C comprises heating the fused quartz article and the doped coating to about 1350 ° C.

[c52] 52.The method according to Claim 42, wherein the doped coating has a thickness from about 50 nm to about 5 microns.

[c53] 53.The method according to Claim 52, wherein the doped coating has a thickness from about 500 nm to about 5 microns.

[c54] 54.The method according to according to Claim 53, wherein the doped coating has a thickness from about 2 microns to about 5 microns.

[c55] 55.The method according to Claim 42, wherein the plurality of metal cations is present within the doped coating in a concentration of at least about 0.5 atomic percent.

[c56] 56.The method according to Claim 55, wherein the plurality of metal cations is

present within the doped coating in a concentration from about 4 atomic percent to about 10 atomic percent.